

<div><div>Draft Version 1.0</div><div><div>Published By</div><div>Naval Air Systems Command</div><div>Human Systems Department, AIR 4.6</div><div>AUG 2017</div></div><div><div>NOTE: This is a DRAFT version of the Human Systems technology/financial roadmap. It is a living document, and is subject to change both in form and content. This edition is based on the AIR 4.6 analysis directed from the AIR 4.6 offsite performed Jan 2017. Subsequent editions will continue this progression based on additional analysis.</div></div></div>			<div><div>HUMAN SYSTEM TECHNOLOGY ROADMAP</div><div>AUG 2017 SNAPSHOT</div></div> <div><div>Disclaimer: The information about to be presented affords industry partners insight into on-going and pending acquisitions.</div><div>Significant portions of the information are planning in nature and are subject to change throughout the acquisition planning and acquisition strategy approval process, and in response to NAVAIRSYSCOM, DASN(A&LM) and DPAP peer reviews.</div></div>										
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
CC1 - Human Systems Engineering, Integration, and Acquisition	CC1 - Research, design, and development of integrated Human Systems products	Develop tools and methodologies for deriving and managing SoS requirements			Tools and Methodologies to derive and manage SoS requirements						<div><div>LEGEND</div><div><div>Funded Capability Enhancement</div><div>Unfunded Potential Capability Development</div><div>Adv Research Or Tech Dev (Unfunded)</div><div>Joint Initiative</div></div></div>		
		Human performance metrics and training solutions that support Integrated Warfare Capabilities (IWC)			Human performance metrics and training solutions that support IWC								
		SoS/Big Data Human performance analysis tools			A hybrid classification approach using down-sampling techniques and tuned hyper parameters on imbalanced datasets (TSD)								
CC2 - Optimized Human Performance and Decision Support	CC2 - Human-Machine Interfaces	Enhance collaborative and autonomous unmanned surveillance and strike capabilities	Adaptive Training for Maintaining Attention during UAS Operations (TSD - SBIR)										
			Identification and Definition of Unmanned Aerial System Air Vehicle Operator Performance Metrics (TSD-BAR)										
			US - Training Experimentation & Simulation (US-TES) Lab (TSD-CIP)										
					Stay Woke and Stay Vigilant: An Examination of Unmanned Operator Performance (TSD-WFD:SG)								
		Enhance battle management decision-making			User Interface Strategies for Human-Machine Team Training in a Simulated Swarm Task (TSD)								
					Management of multiple UAV's and payload systems by a single operator(PAX)								
					Factors involved in operator trust of automation								
		Improve mission planning and real-time re-planning			Novel methods to represent machine state to the operators								
					Techniques and approaches to represent, vary, and adapt the autonomy of controlled/monitored unmanned systems								
		Provide actionable tactical situational awareness		Aircrew Control of Remote Asset Using an Electronic Kneeboard (UAV ctl with EKB) (PAX-BAR)									
	CC2 - Human Performance Measurement and Assessment	Improve manned platform information management and payload, systems, and vehicle control			Enabling technologies for organizing, fusing, and mining data sets to label, organize, and compare diverse more dynamic and automated abilities for rank data types								
					Eye-controlled cursor for display interaction (PAX-BAR)								
					Techniques to minimize computational run times that can integrate HPMs within larger M&S systems and enhance the computational speed and interoperability of HPM tools								
		Identify all contacts and combat classifications; and track and localize potential targets at standoff ranges											
		Improve training outcomes through application of neurophysiological data	Construct Correspondence of Physiological and Subjective Measures of Hypoxia (TSD-ILIR)										
					Cognitive models and objective measures of cognitive decision-making, visual, and auditory workload, and the associated cockpit and collaboration tools								
					Improved modeling of cognitive neuroscience and social or cultural activity								
					Neurocognitive and competency-based assessment data consolidation and interpretation tools								
		Improve warfighter performance through application of psychometric theory			Improving Cognitive Flexibility via Working Memory Training (TSD)								
	Enhanced techniques for individual and team performance assessments			Tool for individual assessment support capabilities to support authoring, storing, selecting, implementing, and exporting performance measures, metrics, methodologies, and measurement results									
		Electronic Warfare (EW) Tactical Decision Aid (TACAID) (TSD-FNC)											
		Personal Assistant for Life Long Learning (TSD-ONR ADV. TECH.)											
	CC2 - Training Methodologies for Distributed Team Competencies	Develop LVC performance assessment technologies and after-action review strategies											
		Develop performance assessment technologies for team integration in distributed cross-platform, cross-warfare teams	Naval Integrated Fire Control- Counter Air (NIFC-CA X) Mission Visualization Tool (TSD-FNC)										
			Squad Overmatch – Tactical Combat Casualty Care (TSD-ATD-Joint)										
			Performance Measurement (PM) Engine (TSD-AWTD)										
					Tools to define new measures and assessments rapidly and then configure them for specific training missions								
		Develop data analyses to facilitate trainee feedback and identify novel performance trends	Basic Electronics and Electricity Learning Environment (BEETLE) II Transition (TSD-219TT)										
					Empirical Support for the Benefits of Performance Measurement Tools (TSD-219TT)								
Develop scenario authoring tool sets that use training network assets and team integration training													
				Tools for rapid scenario generation with appropriate key triggering events to ascertain skill levels									
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CC2 - Optimized Human Performance and Decision Support												<div>LEGEND</div> <div><div>Funded Capability Enhancement</div><div>Unfunded Potential Capability Development</div><div>Adv Research Or Tech Dev (Unfunded)</div><div>Joint Initiative</div></div>
CC2 - Advanced Instructional Techniques	Integrate instructional interventions into virtual environments to train decision-making capabilities	Investigating Low-Cost Untethered Virtual Reality Technologies and the Role of Affordances on Training Effectiveness in an Immersive Environment (TSD-219BAR)										
		Accelerating the Development of Small Unit Decision Making (ADSUDM) (TSD-FNC)										
		Tools to determine the optimal methods of data presentation to learners to maximize the effectiveness of learning and encoding content consistent with cognitive processing requirements										
		Virtual Reality for Training: Do Task Type and Method of Interaction Matter? (TSD)										
		Cockpit Geometry for Virtual Environments (PAX)										
		Distributed Virtual Reality Testbed										
	Develop methods to diagnose and deliver instructional interventions to remediate knowledge and skill deficiencies	Post Mission Assessment for Tactical Training & Trend Analysis (PMATT-TA) (TSD-AWTD)										
		START applied to Medicine: Medic/Corpsman Proficiency Model (MED-PM) (TSD-DoD S&T)										
		Augmented Training for Experiential Learning for Signal Officers (TSD-219TT)										
		Tutoring Effectively: An Assessment of Common Heuristics (TEACH) (TSD-ONR D&I)										
Advanced Adaptive Training methodologies												
Increase the efficiency and effectiveness of the aircraft maintainer through Human Systems Integration (HSI) research (PAX)												
Identifying Training Technology for Enabling Deployable, High Impact Capabilities (TSD)												
Employ game-based training to improve performance	Examining the Effects of Game Features on Learning Scenario Based Training (TSD-BAR)											
	Research Exploring Multi Operator Training Environments (REMOTE) (TSD-WED-SG)											
	Develop mobile training technologies											
CC2 - Applied Human Behavior Modeling	Develop computational models of human performance	Maintainer – Proficiency Model (MAIN-PM) (TSD-BAR)										
	Develop standards for verification, validation, and accreditation (VV&A) of human performance models	Machine learning algorithms that mimic human behavior and performance to recognize, synthesize, and predict patterns in data or sensory stimuli										
	Develop Semi-automated Forces (SAF) models with human-like performance											
CC3 - Advanced Training Systems Technology												
CC3 - High-Fidelity Training Environments	Create software development environments to design and maintain high-fidelity trainers	Database management systems and methods to support rapid or automated database configuration										
		M&S to train and provide engineering test beds in support of research efficacy of various approaches to simulation for training										
		Sound measures of trainee outcomes and rigorous experimental methodologies										
	Develop real-time flight aerodynamic and visual simulation technologies	3D Interactive Aircraft Carrier Operations Planning Tool Prototype (TSD-BAR)										
		Virtual Environment Motion Fidelity Model (TSD-BAR)										
		Effective Measures of Training Display System Performance (TSD-SBIR: N142-104)										
	Develop speech recognition, synthesis functionality, and computational methods to recognize the difference between relevant and irrelevant speech	Extended Field of View (FOV) Video Aviation Training Aids (PAX)										
Visual systems that support high-resolution and multispectral data												
Develop multi-modal sensory simulation systems and integrate into Tactical Software training applications	Multimedia and multisensory interactive displays and environments											
	Natural language interfaces for training											
CC3 - Simulation Interoperability and Distributed LVC Technology	Develop interoperable LVC and Cyber Warfare training simulation and technologies	Crew Role Player Enabled by Automated Technology Enhancements (CREATE) (TSD-SBIR:N142-090)										
		Environment Designed to Undertake Counter A2AD Tactics Training & Experimentation (EDUCAT2E) (TSD-FNC)										
		Network Effects Emulation System (NE2S) (TSD-???)										
		Integrated Warfighting Capabilities (IWC) Fidelity Investigation (TSD-BAR)										
		Live, Virtual& Constructive (LVC) Training Fidelity (TSD-FNC)										
		TEMPEST Modeling and Blackbody Testing for Headsets used in Voice Communication Systems (TSD)										
		Real-Time RF Propagation Modeling in Urban Environments for Virtual and Constructive Training(TSD-BAR)										
		Designing/architecting large scale tng events										
		Verification and Validation of Higher Fidelity Constructive Entities for UAS Training (TSD-BAR)										
		Distributed Virtual Reality Testbed										
	Develop Multi-Level Security Methods to safeguard classified information in the LVC environments	Offensive cyber training capabilities										
		Cyber Security vulnerability (penetration) assessment tools										
		Training system Cyber monitoring tools										
		Low-cost and scalable training solutions										
		Broad RF spectrum analysis test and development capability										
		Defensive cyber training capabilities										
		Cross domain solutions										
Enterprise Network Guard (ENG)												
Develop Mission Rehearsal Enabled Database Methods for collecting and packaging authoritative data feeds	Distributed Synthetic Environment Correlation Architecture and Metrics (TSD-SBBIR:N141-006)											
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Technology	Develop tools for Enhanced Constructive Environments to support instructor inserted dynamic changes to simulated	Cross Domain Maritime Surveillance and Targeting (CDMAST) (TSD-DARPA)										
		Dynamic Adaptive and Modular Entities for UAS (DYADEM) (TSD-FNC)										
		Distributive training research, development and test capability for realistic SAFs										
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CC3 - Advanced Training Systems Technology		environmental conditions													
CC3 - Simulation Interoperability and Distributed LVC Technology		Develop Information Load Management methods, technologies, and tools	Modular Advanced Technologies Marksmanship Proficiency (MAT-MP) (TSD-T2)		State-of-the-art rapid prototyping technology for training design and development							Joint Initiative			
		Develop Navy Continuous Training Environment (NCTE) voice communication technologies to support FST exercises for distributed environments													
CC4 - Human Systems Analysis, Design, and Evaluation		CC4 - Courseware Design	Utility and effectiveness of using Fleet produced maintenance videos as job performance aids												
		CC4 - Training Optimization Analysis	Optimize training event sequencing and media utilization	Medical Training Validation 2 (MTV2) (TSD--DOD S&T)		Training System Requirements Analysis (TSRA) traceability automation tools			Improved methods for TSRA to support IWC analyses						
			Improved methods for TSRA to support maintenance training analyses												
		CC4 - Training Effectiveness Evaluation (TEE)	Determine level of training effectiveness and outcome improvement strategies												
CC5 - Determine Injury Mechanisms		Develop human and vehicle kinematic modeling	Human injury & fatigue modeling												
			Seat performance modeling												
		Aircrew Accommodation Lab Digital Human Modeling (DHM) Capabilities													
		Develop test fixtures for dynamic physical re-creation of vehicle crash, aircraft ejection, and windblast													
		Develop musculoskeletal injury modeling and risk prediction	Whole body injury prediction modeling												
			Low-back pain modeling												
		Portable Human Vibration Measurements													
		Neck injury metrics & modeling													
		Develop thermoregulatory modeling to predict response to cold water immersion and extreme temperatures exposures													
		Develop models to correlate excessive noise/laser exposure with hearing/eye damage	Improved flight deck personnel & maintainer (Triple) Hearing Protection												
			Earplug integrated pressure sensors												
			Earplug venting												
			Ultrasonic wireless communications development												
Non-invasive Custom Ear Canal mapping and On-site Custom Earplug manufacturing															
On-site Custom Earplug manufacturing															
Improved Ear seal material															
Active Noise Reduction assessment methodology															
Improved Earcup material															
Active Noise Reduction device evaluation															
Wireless Earplugs															
In-ear/on-person noise exposure dosimetry															
Improved FW Hearing Protection Non-invasive Ear Canal mapping			Improved Jet (ANR) Hearing Protection												
			Improved Flight Deck and Aircrew Hearing Protection												
			On-site Custom Earplug Provision Improved FW Prop & Rotary Wing (ANR) Hrg Prot												
CC5 - Warfighter Protection, Performance, and Survivability		Develop life support systems (LSS) to improve parachute performance	Improved parachute materials												
			Improved parachute materials & head restraint designs												
		Parachute probabilistic modeling													
		Improved Fixed Wing non-ejection parachute/restraint system													
		NACES Envelope Expansion (Improved drogue chute, thrust direction, parachute)													
		NACES envelope expansion (Improved head and neck restraints); Improved FW non-eject chute & restraint													
		Develop mitigation technologies to offset the effects of acceleration loading during normal and emergency operations	Air bladder pressurized G Suits Improved durability materials												
						Improved maintainability G Suit									
						Fatigue indicating webbings									
						Improved Aircrew & passenger crash protection & egress									
			Improved NACES ejection seat Sustainability: Sequencer redesign & Service Life Assessment Program												
			Ejection Seat component surveillance												
			Aircrew restraint pre-tensioner												
			Crash dynamics recording												
			Gunner Seat ergonomic improvements												
Lumbar support improvements			Custom cushions & lumbar support												
Active high-endurance seat cushion															
Active vibration dampening															
		Lap belt pre-tensioner													

CC5- Warfighter Protection, Performance, and Survivability	CC5- Develop Injury Prevention and Mitigation technologies	Develop mitigation technologies to offset the effects of acceleration loading during normal and emergency operations			Improved crash dynamics recording									
					Lower profile emergency egress bottles									
							Higher endurance seat cushion							
							Personal Lumbar Support							
							Improved endurance MH-60 Gunner Seat							
									Reduced weight & bulk man-mounted survival equipment					
	Develop life support systems (LSS) to protect against environmental stresses			Improved fire protection & durability flight suit material										
				Improved Multi-Climate Protection materials										
				Improved Multi-Climate Protection materials										
				Improved Undergarment thermal regulation										
			Mask-on Hypoxia Training Device											
			E-2D airframe vibration study											
			Cold-weather footwear & extreme foul weather gear											
					Thermoregulatory product exploration									
					Cold Weather Boots									
							Regulated body cooling							
									Regulated body heating					
					Human vibration measurement									
						Seat vibration induced injury reduction								
Develop LSS to protect against ballistic, directed energy, CBRN and vision threats			Contamination Indicator Decontamination Assurance System (CIDAS)											
			Biological agent aircraft decontamination system											
			Chemical agent detection system											
			Lighter weight, lower bulk, improved protection coveralls											
					Uniform Integrated Protection Ensemble (UIPE) products									
			Ballistic injury modeling											
							Shipboard Chem Bio Aircraft Decontamination							
							Stand Off chemical agent detection							
							Lightweight, reduced bulk, flexible ballistic protection							
	Develop technologies to monitor human physiologic response and LSS functionality			Aircrew Physiologic Monitoring and Warning System										
			Cognitive Recovery Time after Hypoxia Exposure											
			Effects of Low Frequencies on Aircrew											
			Determination of the Effect of Exercise on Physiologic and Cognitive Response to Exposure to Hypoxic Hypoxia											
Develop enhanced research protocols to determine LSS effectiveness to support cognitive and physiologic response against military relevant threats				Physiologic and cognitive effect of a multi-stress environment on performance in a flight simulator										
				Placebo Effect of Hypoxia Using the ROB-D										
				Construct Correspondence of Physiologic and Subjective Measures of Hypoxia										
CC5- Ensure Warfighter and Support Personnel Accommodation		Create and validate 3-D computer models of humans, equipment, controls, cockpits and workstations												
		Design, develop, and validate Digital Human Models to determine physical limitations and optimize warfighter and maintainer cockpits, workstations, and work-area design			Digital Human Modeling									
Improve ability to quantify speech intelligibility performance and effectiveness of hearing protection devices and communications systems					Ultrasonic wireless communications producibility									
CC5- Develop/Evaluate Electro-Optical (EO) Sensors, Displays, Interfaces and Devices	Develop analog and digital head mounted systems; audio, tactile, and visual displays			Improved maintainer & flight deck personnel head protection										
				Common RW Helmet										
				Helmet/Head & Neck injury modeling										
						Common RW Helmet enhancements								
								Common FW Helmet						
								Improved Fixed Wing helmet fit, HMD stability & maintainability						
								Low cost digital interface eyepiece for Rotary Wing						
								See-through display technology development						
								Automatic Tinting for display visor development						
										Next generation day/night tactical helmet: high resolution, all-weather, multi-spectral display with tactical data overlay				
								Human Vision Test System Technology Transfer						
								Field of View Effectiveness Study						
								New Capability to the Helmet Impact Testing Drop Tower For Testing Inertia Reels and Energy Absorbers						
					2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
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		CC5- Develop/Evaluate Electro-Optical (EO) Sensors, Displays, Interfaces and Devices	Develop and validate automated machine vision test capabilities			Eye protection integrity monitor								
				Soft armor assessment (Army)										
						Enhanced soft material armor								

